Research Center for Photovoltaics

Analysis of delay effect by UV irradiation during PID stress test for p-type crystalline Si solar cells

Dong C. Nguyen[1], Atsushi Masuda[2], Yasuaki Ishikawa[1], Yukiharu Uraoka[1]

[1]Division of Materials Science, Nara Institute of Science and Technology
[2]National Institute of Advanced Industrial Science and Technology

1. Motivation

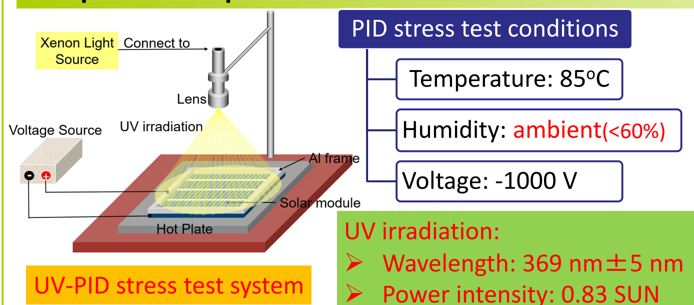
UV light irradiation on solar modules during PID stress tests shows PID delay effect [1].

The mechanism causing the PID delay effect by UV irradiation needs to be analyzed.

Analysis of PID delay effect by UV irradiation is performed by using the μ-PCD technique.

[1] A. Masuda, Y. Hara, Jpn. J. Appl. Phys. 57, 08RG13 (2018).

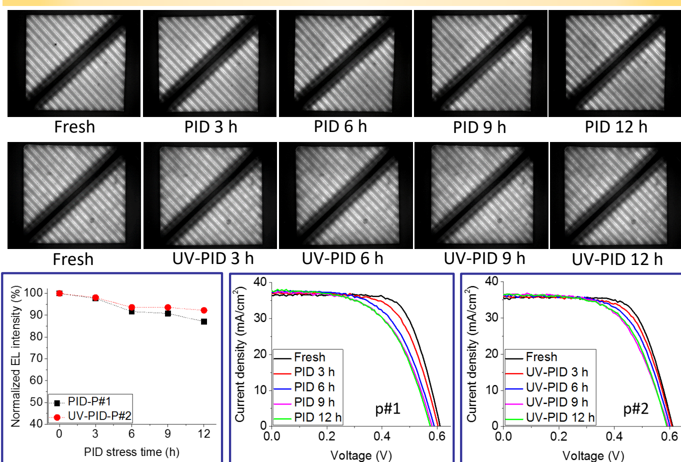
2. Experimental procedure



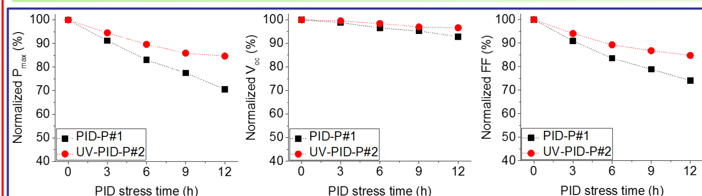
UV irradiation:
- Wavelength: 369 nm±5 nm
- Power intensity: 0.83 SUN

3. Results and Discussion

Electrical characteristics of two modules after PID stress tests

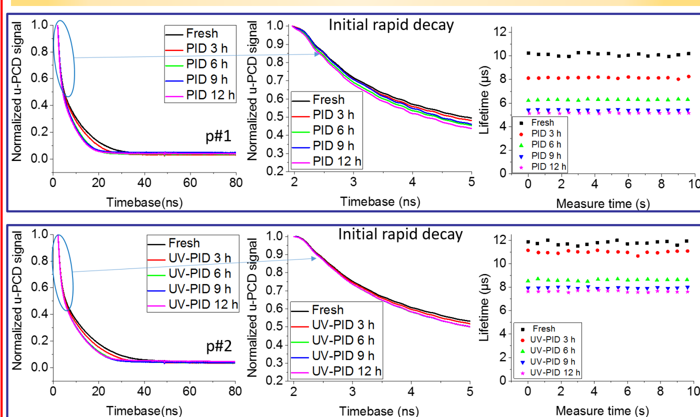


☺ The **EL intensity reduction** can be observed in **both modules** after the PID stress tests with and without **UV irradiation**.
☺ The **reduction level** of **module #1** is **stronger** than that of **module #2**.



☺ The **degradation level** of P_{max}, V_{oc}, and FF in case **without** UV irradiation is **higher** than that in case **with** UV irradiation.
☺ The **degradation level** is in **agreement** with the comparison of normalized **EL intensity**.

μ-PCD signals in both cases with and without UV irradiation



☺ **The rapid decay rate** in case **w/o** UV irradiation **gradually reduces** for test time until **12 h**, but that **with** UV irradiation almost **doesn't reduce** for test time longer than **6 h**.
☺ The **effective lifetime (τ_{eff})** also gradually **reduces** after the PID stress tests in both cases as a **function** of PID stress time.

PID	p#1 without UV τ_{eff} (μs)	p#2 with UV τ_{eff} (μs)
Fresh	10.07±0.04	12.02±0.32
3 h	8.58 ±0.33	11.08±0.08
6 h	6.26 ±0.03	8.70±0.03
9 h	5.77 ±0.01	7.95±0.03
12 h	5.10 ±0.06	7.58±0.06

✓ The τ_{eff} **reduction level** in case without UV irradiation is **stronger** than that with UV irradiation.
✓ The reduction behavior of τ_{eff} is a **good correlation** with the degradation behavior of P_{max}, V_{oc}, **and FF.**

5. Conclusions

- UV irradiation during PID stress tests shows PID delay effect for p-type Si modules.
- The rapid decay rate and lifetime reduction levels in case without UV irradiation is stronger than that with UV irradiation.
- The reduction behavior of effective lifetime is a good correlation with the degradation behavior of P_{max}, V_{oc}, and FF.

Acknowledgments

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